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Anticariogenic Activity of Selenium Nanoparticles with *Pterocarpus santa*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Nanoparticles (NPs) are used to minimise toxicity, increase bioactivity, improve targeting, and monitor the release profile of the encapsulated moiety in a variety of ways. Inorganic NPs such as Ag, Au, Ce, Fe, Se, Ti, and Zn hold a special position among NPs due to its versatile bioactivities in nanoforms.Selenium (Se) is an essential trace mineral.SeNPs have been studied in the treatment of oxidative stress and inflammation-related diseases such as arthritis, cancer, diabetes, and nephropathy.Medicinal plants have long been a valuable source of natural active constituents that have been used in products for preserving human health. *Pterocarpus santalinus* (Fabaceae) has been used as a folk medicine and has been shown to have anti-inflammatory, anti-ulcer, and anti-cancer properties. The aim of the present work is to evaluate synergistic Anticariogenic properties of *Pterocarpus santalinus* (red sandalwood).

Materials and Methods: Anticariogenic activity of respective nanoparticles against the strain staphylococcus aureus, Candida albicans, and Enterococcus faecalis and s.mutans . MHA agar was utilized for this activity to determine the zone of inhibition. Muller Hinton agar was prepared and sterilized for 45 minutes at 120lbs. Media poured into the sterilised plates and let them stabilize for solidification. The wells were cut using the well cutter and the test organisms were swabbed.The

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nanoparticles with different concentrations were loaded and the plates were incubated for 24 hours at 37°C. After the incubation time the zone of inhibition was measured.

Results: Agar well diffusion demonstrated that Pterocarpus santa significantly inhibited the growth of *S.Aureus, S.mutans, E. faecalis and C.albicans* . The increase in concentration increases the zone of inhibition.Data were implied as mean ± SEM with the level of statistical significance at $p<0.05$.

Conclusion: Selenium nanoparticles were synthesised from *Pterocarpus santa* and they are characterised .Their special study showed the potent anticariogenic activity against pathogens.

Keywords: Anticariogenic activity; selenium nanoparticles; Pterocarpus selenium.

1. INTRODUCTION

Nanotechnology is the study and control of matter with dimensions of 1–100 nanometers. The use of precisely designed materials at this length scale to establish novel therapeutic and diagnostic modalities is known as nanomedicine, which is the application of nanotechnology to medicine. Nanomaterials have unique physicochemical properties that distinguish them from bulk materials of the same composition, such as ultra-small scale, large surface area to mass ratio, and high reactivity. These features can be used to get around some of the disadvantages of conventional therapeutic and diagnostic agents [1].The promise of breakthrough developments in medicine, electronics, genomics, and robotics fuelled the growth of nanotechnology [2].Current diagnostic and treatment modalities for a variety of diseases, especially cancer, have significant flaws such as low sensitivity or precision, as well as drug toxicity. On the basis of nanoparticles, new and improved cancer detection methods are being developed [3]. They're used as contrast agents, fluorescent products, molecular testing instruments, and medications that have antibodies that target them.Magnetic nanoparticles, quantum dots, nanoshells, and nanosomes are only a few examples of nanoparticles used in diagnostics [4]. With the help of nanotechnology, medicines with a high toxic potential, such as cancer chemotherapeutic drugs, can be provided with a better safety profile [5].

Nanoparticles (NPs) are used to minimise toxicity, increase bioactivity, improve targeting, and monitor the release profile of the encapsulated moiety in a variety of ways. Inorganic NPs such as Ag, Au, Ce, Fe, Se, Ti, and Zn hold a special position among NPs due to its versatile bioactivities in nanoforms [6].Particulate systems, such as nanoparticles, have been used to modify and enhance the pharmacokinetic and pharmacodynamic properties of different drug molecules utilising a physical method [7]. (Se) is an essential trace mineral [8]. As selenocysteine, it is integrated into selenoproteins and serves as the most essential component of the active core of their enzymatic activities. Many selenoproteins have oxidoreductase activity and thus control the redox balance in the body [8]. She has a small therapeutic window and fragile toxicity margins, whereas Se nanoparticles (SeNPs) have significantly reduced toxicity [6,8]. SeNPs have been studied in the treatment of oxidative stress and inflammation-related diseases such as arthritis, cancer, diabetes, and nephropathy [9]. Selenium is commonly used as a dietary supplement , owing to its links to immunity and cancer prevention . Heavy metals and selenium have a well-known relationship [10]. SeNPs are an appealing carrier vehicle for transporting different drugs to the site of operation [11]. Seleno-compounds can be used as chemopreventive and chemotherapeutic agents. SeNPs play a key role in bacterial growth inhibition at very low protein concentrations, while a large amount of protein is needed to inhibit bacterial growth individually [12].

Medicinal plants have long been a valuable source of natural active constituents that have been used in products for preserving human health and treating a wide range of diseases. Pterocarpus santalinus wood is in high demand and earns a lot of money in foreign exchange. The species is native to Andhra Pradesh, restricted to a small region in the districts of Cuddapah, Kurnool, and Chittoor. The tract's ecological features include Algonkian slate and quartzite geological terrain, as well as a rainfall regime that is halfway between the tropical form of the interior Deccan and the Coromandel-coast [13]. Scientific name: *P. santalinus Linn.* f. belongs to fabaceae family. *Pterocarpus santalinus* (Fabaceae) has been used in Korea as a folk medicine and has been shown to have anti-inflammatory, anti-ulcer, and anti-cancer properties [14]. Inflammations, emotional aberrations, ulcers, and cancer have all been treated with this herb as a folk remedy.

Isoflavonoids, terpenoids, aurone glycosides, and lignans were discovered in previous phytochemical studies on the *Pterocarpus santalinus* [14]. We had previously done research on these topics for the past 5 year (red sandalwood) [15–23].Our team has extensive knowledge and research experience that has translate into high quality publications [24–34],[26,35–43]. The aim of the present work is to evaluate synergistic Anticariogenic properties of *Pterocarpus santalinus*.

2. MATERIALS AND METHODS

2.1 Synthesis of Selenium Nanoparticles

Selenium nanoparticles were made by measuring 0.5g of red sandal selenium and adding 50 ml of distilled water to it. The extract is now boiled for 10 minutes at 55 degrees Celsius. The extract was then purified until sodium selenite was added.

2.2 Antibacterial Activity

Anticariogenic activity of respective nanoparticles against the strain *Staphylococcus aureus, Candida albicans, and Enterococcus faecalis and S.mutans*. MHA agar was utilized for this activity to determine the zone of inhibition. Muller Hinton agar was prepared and sterilized for 45 minutes at 120lbs. Media poured into the sterilised plates and let it stable for solidification. The wells were cut using the well cutter and the test organisms were swabbed.The nanoparticles with different concentration were loaded and the plates were incubated for 24 hours at 37 ° C. After the incubation time the zone of inhibition was measured.Data were implied as mean ± SEM with the level of statistical significance at $p<0.05$.

3. RESULTS

The zone of inhibition for *E. faecalis* at 25µl is 22, the zone of inhibition of 50 µl is 21, the zone of inhibition of 100µl is 20, the zone of inhibition of standard is 40 .The zone of inhibition for *S.mutans* at 25µl is 20, the zone of inhibition of 50 µl is 21, the zone of inhibition of 100µl is 22, the zone of inhibition of standard is 30.The zone of inhibition for *S. aureus* at 25µl is 20, the zone of inhibition of 50 µl is 21, the zone of inhibition of 100µl is 25, the zone of inhibition of standard is 27.The zone of inhibition for *C.albicans* at 25µl is 20, the zone of inhibition of 50 µl is 22, the zone of inhibition of 100µl is 25, the zone of inhibition of standard is 15. Among all the bacteria and fungi the zone of inhibition of *C.albicans* is good. As the concentration increases the zone of inhibition also increases.

4. DISCUSSION

Pterocarpus santa along with selenium nanoparticles has a positive outcome in the present study.It has also shown that it shows a great effect on anticariogenic activity.previous studies have been done using P. santalinus L. has long been used to treat diabetes and the heartwood extract has been shown to have antioxidant ,anti-inflammatory , anti-cancer , gastro-protective and wound-healing properties. The antioxidant potential of methanol extracts from bark, and wood of P. santalinus L was very evident. The powder made from the wood of P. santalinus L. could speed wound healing without causing any negative side effects [44]. Previous article stated that the yields of *Pterocarpus macrocarpus* and *Pterocarpus soyauxii* were particularly high among the ethanol extracts, with 28.39 percent and 28.59 percent, respectively [45,46]. At 2 g/L, 4 g/L, and 2 g/L, respectively, *Pterocarpus angolensis, Pterocarpus macrocarpus, and Pterocarpus soyauxii* achieved grade I corrosion resistance [46].

Selenium nanoparticles can be made utilizing a variety of processes, including biological, chemical, and physical processes [47]. The manufacture of selenium nanoparticles from biological sources such as bacteria, fungus, yeasts, and plants has been reported in a number of works [47]. Chemicals have also been employed to convert sodium selenite into selenium nanoparticles as a reducing agent.TEM, SEM, FTIR, XRD, and UV-vis are used to analyze synthesized selenium nanoparticles [47]. Nanotechnology advancements have enabled the creation of customized metal/metalloid nanoparticles with physicochemical characteristics that inhibit bacteria. Existing drug resistance mechanisms, such as slow drug uptake and accelerated efflux, biofilm formation, and intracellular bacterial parasitism, have been shown to be overcome by these nanoparticles [48]. SeNPs have antibacterial, antiviral, and antioxidant activities, indicating that they might be used to treat

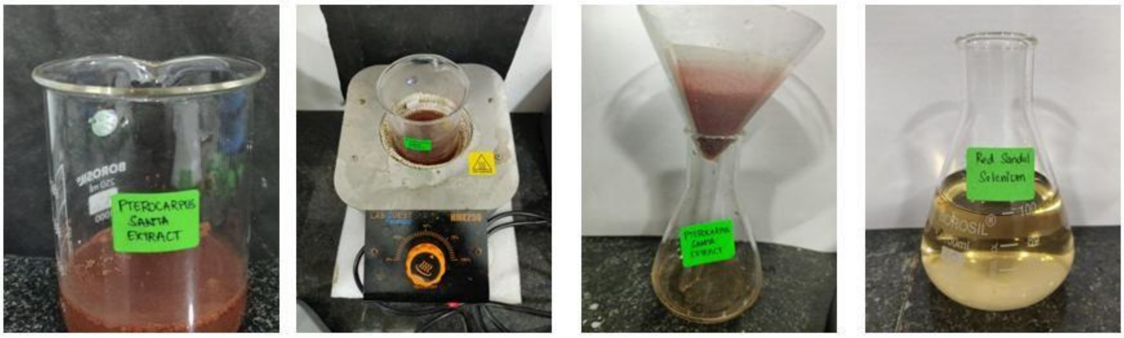

Fig. 1. Green synthesis of *pterocarpus santa* mediated selenium nanoparticles

Fig. 2. Image showing the Zone of Inhibition of P.santa mediated selenium nanoparticle

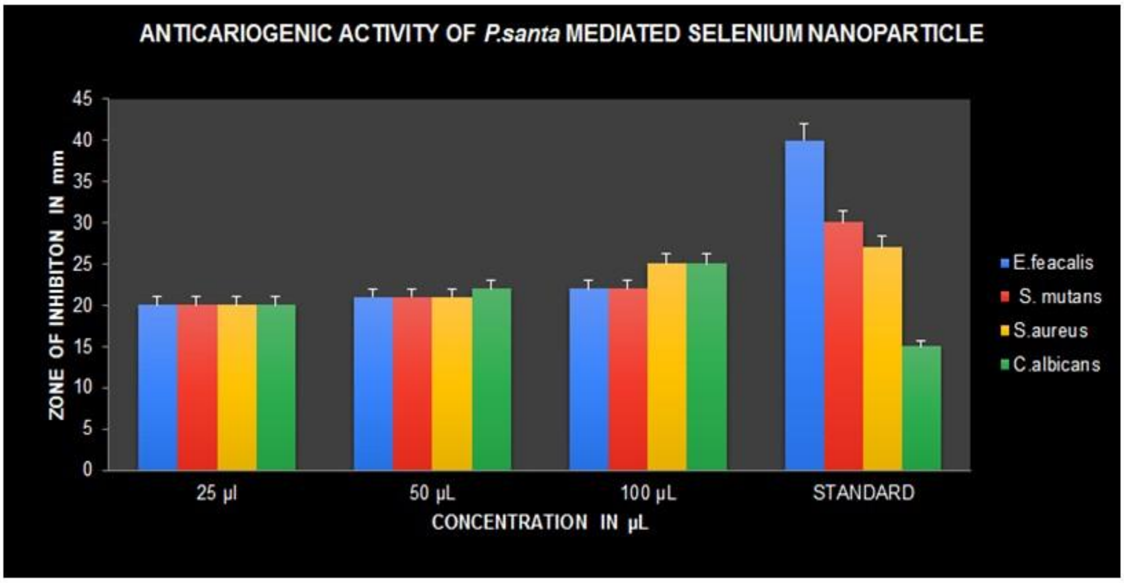

Fig. 3. The bar graph depicts the Anticariogenic activity of selenium nanoparticles synthesised from the extract of *Pterocarpus santalinus.*x axis represents the concentration and y axis represents the zone of inhibition in mm, data implies as mean±SEM

infectious illnesses as therapeutic possibilities [48]. Nanostructured particles, in particular, may be produced utilizing bacterial and fungal cells as biological catalysts, resulting in a non-toxic and ecologically friendly method of producing nanoparticles, such as SeNPs [48]. From the previous article, Lampis described SeNPs as having a typical spherical form and a diameter of 50–400 nm. Furthermore, biogenic SeNPs have been shown to exhibit anti-biofilm action against clinical isolates of bacterial pathogens in recent investigations [48].

The small margin between therapeutic and hazardous levels of selenium, on the other hand, limits its use in dietary supplements [45]. The therapeutic and harmful effects of selenium are strongly tied to its chemical forms, according to a large body of evidence. The redox process has been shown to produce orange-red and zero-valent selenium nanoparticles (SeNPs) with better properties [45]. When compared to other chemical species of selenium, orange-red and zero-valent selenium nanoparticles (SeNPs) generated through the redox process exhibit superior bioavailability but lower toxicity. SeNPs, on the other hand, are often unstable and easily aggregate into grey and black elemental selenium [45]. Polysaccharides have been employed as templates to increase the stability of SeNPs in previous studies. Fungi have long been known to be rich in bioactive polysaccharides. Fungal polysaccharides have a wide range of biological functions, including gut microbiota control, immunomodulatory, and anti-cancer effects. The limitations of this study was that the zone of inhibition was only tested on a few microbes. Future studies will be done on *Pterocarpus santa* and selenium nanoparticles to implement it in the drugs formulation for clinical trials [49-62].

5. CONCLUSION

Selenium nanoparticles were synthesised from *Pterocarpus santa* and they are characterised. Their special study showed the potent anticariogenic activity against pathogens [63-72]. As a result, SeNPs capped with polysaccharides are predicted to improve the benefits of selenium and may have synergistic activity.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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